

WHAT IS CLAIMED IS:

1. An ultraviolet light curable composition useful for repairing composite materials, comprising: an acrylic oligomer, an acrylic monomer, a photoinitiator, and fiberglass.
2. The composition of claim 1, wherein the acrylic oligomer is an epoxy acrylate, urethane acrylate, polyester acrylate, polyether acrylate, amine modified polyether acrylate, acrylic acrylate, or combination thereof.
3. The composition of claim 1, wherein the acrylic oligomer is an epoxy acrylate.
4. The composition of claim 1, comprising two or more oligomers, two or more acrylic monomers, two or more photoinitiators, or combination thereof.
5. The composition of claim 1, wherein the acrylic monomer is selected from the group consisting of methyl methacrylate (MMA), ethyl methacrylate, methacrylic acid (MA), isobornyl methacrylate (ISBM), ethylene glycol dimethacrylate (EGDM), ethoxylated bisphenol A diacrylate esters (BPADAE), tetraethylene glycol dimethacrylate (TEGDM), diethylene glycol dimethacrylate (DEGDM), diethylene glycol diacrylate (DEGDA), tris(2-hydroxyethyl) isocyanurate triacrylate (ISOTRI); a diacrylate, an alkyl or hydroxy alkyl esters of acrylic acid; a diacrylate, an alkyl or hydroxy alkyl esters of methacrylic acid; butyleneglycol diacrylate and triacrylate, 1,6-hexanediol diacrylate, tetraethyleneglycol diacrylate and triacrylate, polyethylene glycol diacrylate and triacrylate, bisphenol A diacrylate and triacrylate, pentaerythritol diacrylate and triacrylate and tetraacrylate; methyl acrylate, ethyl acrylate, butyl acrylate, 2-ethylhexyl acrylate, 2-hydroxyethyl acrylate, isobornyl acrylate, ethylene glycol diacrylate, propylene glycol diacrylate, neopentyl glycol diacrylate, hexamethylene glycol diacrylate, 4,4'-bis(2-acryloyloxyethoxy)diphenylpropane, trimethylolpropane triacrylate, vinyl acrylate, and combinations thereof.
6. The composition of claim 1, comprising as the acrylic monomer a combination of tris(2-hydroxyethyl)isocyanurate triacrylate, isobornyl methacrylate, methyl methacrylate, 1,6-hexanediol diacrylate, and methacrylic acid.

- 1 7. The composition of claim 1, wherein the composition comprises about 10 to about 50
2 percent by weight of the acrylic oligomer, about 20 to about 60 percent by weight of the
3 acrylic monomer, about 0.5 to about 3 percent by weight of the photoinitiator, and about 25
4 to about 75 percent by weight of the fiberglass.
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- 6 8. The composition of claim 1, wherein the wherein the photoinitiator is a combination
7 of a bis-acylphosphine oxide and an alpha hydroxy ketone.
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- 9 9. The composition of claim 1, wherein the photoinitiator is a combination of a bis-
10 acylphosphine oxide and an alpha hydroxy ketone, and wherein the bis-acylphosphine oxide
11 to alpha hydroxy ketone ratio is from about 1:4 to about 4:1.
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- 13 10. The composition of claim 1, wherein the cured composition has a T_g greater than
14 150°C .
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- 16 11. An ultraviolet light curable formulation, comprising: an acrylate oligomer, a
17 combination of two or more acrylic monomers, a bis-acylphosphine oxide and an alpha
18 hydroxy ketone, wherein the cured formulation formed from the curable formulation has a T_g
19 greater than 150°C .
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- 21 12. The formulation of claim 11, wherein the acrylic oligomer is an epoxy acrylate,
22 urethane acrylate, polyester acrylate, polyether acrylate, amine modified polyether acrylate,
23 acrylic acrylate, or combination thereof.
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- 25 13. The formulation of claim 11, wherein the acrylic oligomer is an epoxy acrylate.
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- 27 14. The formulation of claim 11, wherein the acrylic monomer is selected from the group
28 consisting of: methyl methacrylate (MMA), ethyl methacrylate, methacrylic acid (MA),
29 isobornyl methacrylate (ISBM), ethylene glycol dimethacrylate (EGDM), ethoxylated
30 bisphenol A diacrylate esters (BPADAE), tetraethylene glycol dimethacrylate (TEGDM),
31 diethylene glycol dimethacrylate (DEGDM), diethylene glycol diacrylate (DEGDA), tris(2-
32 hydroxyethyl) isocyanurate triacrylate (ISOTRI); a diacrylate, an alkyl or hydroxy alkyl
33 esters of acrylic acid; a diacrylate, an alkyl or hydroxy alkyl esters of methacrylic acid;
34 butyleneglycol diacrylate and triacrylate, 1,6-hexanediol diacrylate, tetraethyleneglycol

diacrylate and triacrylate, polyethylene glycol diacrylate and triacrylate, bisphenol A diacrylate and triacrylate, pentaerythritol diacrylate and triacrylate and tetraacrylate; methyl acrylate, ethyl acrylate, butyl acrylate, 2-ethylhexyl acrylate, 2-hydroxyethyl acrylate, isobornyl acrylate, ethylene glycol diacrylate, propylene glycol diacrylate, neopentyl glycol diacrylate, hexamethylene glycol diacrylate, 4,4'-bis(2-acryloyloxyethoxy)diphenylpropane, trimethylolpropane triacrylate, vinyl acrylate, and combinations thereof.

15. The formulation of claim 11, comprising as the acrylic monomer a combination of tris(2-hydroxyethyl)isocyanurate triacrylate, isobornyl methacrylate, methyl methacrylate, 1,6-hexanediol diacrylate, and methacrylic acid.

16. The formulation of claim 11, wherein the formulation comprises about 20 to about 70 percent of the acrylic oligomer, about 30 to about 80 percent of the two or more acrylic monomers, and 0.5 to about 3 percent of the photoinitiator.

17. The formulation of claim 11, wherein the photoinitiator is a combination of a bis-acylphosphine oxide and an alpha hydroxy ketone, wherein the bis-acylphosphine oxide to alpha hydroxy ketone ratio is from about 1:4 to about 4:1.

18. A reaction product formed by irradiation of the ultraviolet light curable composition of claim 1.

19. A method which comprises: combining an acrylic oligomer, an acrylic monomer, and a photoinitiator; applying the resulting ultraviolet light curable formulation to fiberglass to thereby form an ultraviolet light curable composition.

20. The method of claim 19, wherein the acrylic oligomer is an epoxy acrylate, urethane acrylate, polyester acrylate, polyether acrylate, amine modified polyether acrylate, acrylic acrylate, or combination thereof.

21. The method of claim 19, wherein the acrylic oligomer is an epoxy acrylate.

22. The method of claim 19, wherein the acrylic monomer is selected from the group consisting of: methyl methacrylate (MMA), ethyl methacrylate, methacrylic acid (MA),

1 isobornyl methacrylate (ISBM), ethylene glycol dimethacrylate (EGDM), ethoxylated
2 bisphenol A diacrylate esters (BPADAE), tetraethylene glycol dimethacrylate (TEGDM),
3 diethylene glycol dimethacrylate (DEGDM), diethylene glycol diacrylate (DEGDA), tris(2-
4 hydroxyethyl) isocyanurate triacrylate (ISOTRI); a diacrylate, an alkyl or hydroxy alkyl
5 esters of acrylic acid; a diacrylate, an alkyl or hydroxy alkyl esters of methacrylic acid;
6 butyleneglycol diacrylate and triacrylate, 1,6-hexanediol diacrylate, tetraethyleneglycol
7 diacrylate and triacrylate, polyethylene glycol diacrylate and triacrylate, bisphenol A
8 diacrylate and triacrylate, pentaerythritol diacrylate and triacrylate and tetraacrylate; methyl
9 acrylate, ethyl acrylate, butyl acrylate, 2-ethylhexyl acrylate, 2-hydroxyethyl acrylate,
10 isobornyl acrylate, ethylene glycol diacrylate, propylene glycol diacrylate, neopentyl glycol
11 diacrylate, hexamethylene glycol diacrylate, 4,4'-bis(2-acryloyloxyethoxy)diphenylpropane,
12 trimethylolpropane triacrylate, vinyl acrylate, and combinations thereof.

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14 23. The method of claim 19, wherein the acrylic monomer is a combination of tris(2-
15 hydroxyethyl)isocyanurate triacrylate, isobornyl methacrylate, methyl methacrylate, 1,6-
16 hexanediol diacrylate, and methacrylic acid.

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18 24. The method of claim 19, wherein the formulation comprises about 20 to about 70
19 percent by weight of the acrylic oligomer, about 30 to about 80 percent by weight of the
20 acrylic monomer, and about 0.5 to about 3 percent by weight of the photoinitiator.

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22 25. The method of claim 19, wherein the wherein the photoinitiator is a combination of a
23 bis-acylphosphine oxide and an alpha hydroxy ketone.

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25 26. The method of claim 19, wherein the wherein the photoinitiator is a combination of a
26 bis-acylphosphine oxide and an alpha hydroxy ketone, wherein the bis-acylphosphine oxide
27 to alpha hydroxy ketone ratio is from about 1:4 to about 4:1.

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29 27. The method of claim 19, further comprising irradiating the ultraviolet light curable
30 formulation with UV light to cure the UV curable composition.

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32 28. The method of claim 27, wherein the acrylic oligomer is an epoxy acrylate, urethane
33 acrylate, polyester acrylate, polyether acrylate, amine modified polyether acrylate, acrylic
34 acrylate, or combination thereof.

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2 29. The method of claim 27, wherein the acrylic oligomer is an epoxy acrylate.
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4 30. The method of claim 27, wherein the acrylic monomer is selected from the group
5 consisting of: methyl methacrylate (MMA), ethyl methacrylate, methacrylic acid (MA),
6 isobornyl methacrylate (ISBM), ethylene glycol dimethacrylate (EGDM), ethoxylated
7 bisphenol A diacrylate esters (BPADAE), tetraethylene glycol dimethacrylate (TEGDM),
8 diethylene glycol dimethacrylate (DEGDM), diethylene glycol diacrylate (DEGDA), tris(2-
9 hydroxyethyl) isocyanurate triacrylate (ISOTRI); a diacrylate, an alkyl or hydroxy alkyl
10 esters of acrylic acid; a diacrylate, an alkyl or hydroxy alkyl esters of methacrylic acid;
11 butyleneglycol diacrylate and triacrylate, 1,6-hexanediol diacrylate, tetraethyleneglycol
12 diacrylate and triacrylate, polyethylene glycol diacrylate and triacrylate, bisphenol A
13 diacrylate and triacrylate, pentaerythritol diacrylate and triacrylate and tetraacrylate; methyl
14 acrylate, ethyl acrylate, butyl acrylate, 2-ethylhexyl acrylate, 2-hydroxyethyl acrylate,
15 isobornyl acrylate, ethylene glycol diacrylate, propylene glycol diacrylate, neopentyl glycol
16 diacrylate, hexamethylene glycol diacrylate, 4,4'-bis(2-acryloyloxyethoxy)diphenylpropane,
17 trimethylolpropane triacrylate, vinyl acrylate, and combinations thereof.
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19 31. The method of claim 27, wherein the acrylic monomer is a combination of tris(2-
20 hydroxyethyl)isocyanurate triacrylate, isobornyl methacrylate, methyl methacrylate, 1,6-
21 hexanediol diacrylate, and methacrylic acid.
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23 32. The method of claim 27, wherein the formulation comprises about 20 to about 70
24 percent by weight of the acrylic oligomer, about 30 to about 80 percent by weight of the
25 acrylic monomer, and about 0.5 to about 3 percent by weight of the photoinitiator.
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27 33. The method of claim 27, wherein the wherein the photoinitiator is a combination of a
28 bis-acylphosphine oxide and an alpha hydroxy ketone.
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30 34. The method of claim 27, wherein the wherein the photoinitiator is a combination of a
31 bis-acylphosphine oxide, wherein the bis-acylphosphine oxide to alpha hydroxy ketone ratio
32 is from about 1:4 to about 4:1.
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34 35. A method of repairing a hole in the exterior of an airplane, comprising:

1 applying alternating layers of (1) an ultraviolet light curable formulation and (2)
2 woven fiberglass fabric to fill the hole and to form an ultraviolet light curable composition;
3 creating a vacuum across at least one side of the ultraviolet light curable composition;
4 irradiating the ultraviolet light curable formulation with ultraviolet light to cure the
5 formulation to produce a cured composition; and
6 removing the vacuum.

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8 36. The method of claim 35, wherein the ultraviolet light curable formulation comprises:
9 an acrylate oligomer, a combination of two or more acrylic monomers, a bis-acylphosphine
10 oxide and an alpha hydroxy ketone, wherein the cured formulation formed from the curable
11 formulation has a T_g greater than 150°C.

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13 37. The method of claim 35, wherein the acrylic oligomer is an epoxy acrylate, urethane
14 acrylate, polyester acrylate, polyether acrylate, amine modified polyether acrylate, acrylic
15 acrylate, or combination thereof.

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17 38. The method of claim 35, wherein the acrylic oligomer is an epoxy acrylate.

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19 39. The method of claim 35, wherein the acrylic monomer is selected from the group
20 consisting of: methyl methacrylate (MMA), ethyl methacrylate, methacrylic acid (MA),
21 isobornyl methacrylate (ISBM), ethylene glycol dimethacrylate (EGDM), ethoxylated
22 bisphenol A diacrylate esters (BPADAE), tetraethylene glycol dimethacrylate (TEGDM),
23 diethylene glycol dimethacrylate (DEGDM), diethylene glycol diacrylate (DEGDA), tris(2-
24 hydroxyethyl) isocyanurate triacrylate (ISOTRI); a diacrylate, an alkyl or hydroxy alkyl
25 esters of acrylic acid; a diacrylate, an alkyl or hydroxy alkyl esters of methacrylic acid;
26 butyleneglycol diacrylate and triacrylate, 1,6-hexanediol diacrylate, tetraethyleneglycol
27 diacrylate and triacrylate, polyethylene glycol diacrylate and triacrylate, bisphenol A
28 diacrylate and triacrylate, pentaerythritol diacrylate and triacrylate and tetraacrylate; methyl
29 acrylate, ethyl acrylate, butyl acrylate, 2-ethylhexyl acrylate, 2-hydroxyethyl acrylate,
30 isobornyl acrylate, ethylene glycol diacrylate, propylene glycol diacrylate, neopentyl glycol
31 diacrylate, hexamethylene glycol diacrylate, 4,4'-bis(2-acryloyloxyethoxy)diphenylpropane,
32 trimethylolpropane triacrylate, vinyl acrylate, and combinations thereof.

- 1 40. The method of claim 35, comprising as the acrylic monomer a combination of tris(2-
2 hydroxyethyl)isocyanurate triacrylate, isobornyl methacrylate, methyl methacrylate, 1,6-
3 hexanediol diacrylate, and methacrylic acid.
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- 5 41. The method of claim 35, wherein the formulation comprises about 20 to about 70
6 percent of the acrylic oligomer, about 30 to about 80 percent of the two or more acrylic
7 monomers, and 0.5 to about 3 percent of the photoinitiator.
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- 9 42. The method of claim 35, wherein the wherein the photoinitiator is a combination of a
10 bis-acylphosphine oxide and an alpha hydroxy ketone.
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- 12 43. The method of claim 35, wherein the wherein the photoinitiator is a combination of a
13 bis-acylphosphine oxide and an alpha hydroxy ketone, wherein the bis-acylphosphine oxide
14 to alpha hydroxy ketone ratio is from about 1:4 to about 4:1.
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- 16 44. The method of claim 35, wherein the cured composition has a T_g greater than 150°C.
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- 18 45. A reaction product formed by irradiation of the ultraviolet light curable formulation of
19 claim 11.
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